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Planning for CEF Experiments Supporting Stockpile Stewardship and Global Security

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Abstract

- **This presentation summarizes the status of planning for critical assembly experiments at the Device Assembly Facility in support of stockpile stewardship and global security. Eleven proposed experiments have currently been submitted by Los Alamos through the Nuclear Criticality Safety Program's (NCSP) Integral Experiments Request process. The presentation will be given at an upcoming NCSP Technical Seminar to be held at Oak Ridge National Laboratory.**

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Our Perspective: (Criticality is no “Accident”)



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Different Programs have Different Responsibilities Associated with Nuclear Weapons

- **Stockpile Stewardship Program (SSP)**
 - responsible for maintaining the safety, security, and reliability of the nation's nuclear weapons stockpile
- **Nuclear Counter Terrorism (NCT)**
 - identifying and characterizing potential IND material and designs that pose a threat to U.S. citizens, assets, and infrastructure
- **Joint Technical Operations Team (JTOT)**
 - provides specialized technical capabilities in support of lead federal agencies to respond to weapons of mass destruction
- **National Technical Nuclear Forensics (NTNF)**
 - enable operational support for materials, pre-detonation device, and post-detonation nuclear or radiological forensics programs with the broader goal of attribution

Timeline of Current Effort (1)

- **July 13, 2010 – McKamy asks for Stockpile-Stewardship motivated CEF experiments**
- **August 26, 2010 – Little presents initial ideas during C_EdT meeting in Las Vegas**
 - Reaction-rate ratio experiments
 - High-fidelity re-creation of “gold-standard” assemblies used to set uncertainty ‘gates’
 - Experiments for validation of probability-of-initiation calculations
 - Dynamic experiments
 - Alternative materials
 - Experiments with specific reflectors
 - Fission product studies
 - Production of radioactive samples for NTNF exercises
 - Source for INRAD studies
 - High-resolution leakage spectra (neutrons and gammas)
 - Tailored neutron spectra
 - Experiments driven by 14-MeV neutron source
 - New assemblies used as “blind exercises” for ASC codes / physics / designers

Timeline of Current Effort (2)

- **September – October, 2010**
 - LANL determined “top-3” experiments and submitted IERs
 - Obtained LLNL concurrence (thank you!)
- **November 8, 2010 – Ellis’ C_EdT meeting during ANS**
 - Titles provided for additional IERs
- **January 26, 2011 – NCT / NCSP Neutronics Roadmap Meeting at LLNL**
 - Discussion of LANL / LLNL NCT priorities for CEF experiments
 - Six IERs identified as top priorities
 - Results communicated to NCSP Management Team
- **January - February 2011**
 - LANL submits 8 additional IERs in support of stockpile stewardship and global security programs

Resulting IERs Currently in the NCSP System

- IER 137 “High Precision HEU Critical Assembly Measurements to Understand Reproducibility” (Morgan White)
- IER 138 “Probability of Initiation Benchmark Experiments” (Pete Jaegers)
- IER 136 “Reaction Rate and Fission-Product Yield Measurements in Pu-239 and U-238,235” (Todd Bredeweg)
- IER 150 “NCT / NTNF Material # 1” (Bob Little)
- IER 151 “NCT / NTNF Material # 2” (Bob Little)
- IER 154 “Be Reflector Studies” (Skip Kahler)
- IER 153 “Measure The Fission Neutron Spectrum Shape Using Threshold Activation Detectors” (Morgan White)
- IER 152 “High Precision Plutonium Critical Assembly Measurements” (Morgan White)
- IER 155 “NCT / NTNF Material # 3” (Bob Little)
- IER 156 “NCT / NTNF Material # 4” (Bob Little)
- IER 157 “NCT / NTNF material # 5” (Bob Little)

Key Objectives Common to Submitted IERs

- **Benchmark Quality**
 - Material characterization
 - Assembly details
 - Experimental environment
- **Focus on Uncertainties**
 - While planning, performing, and documenting the experiment
 - Uncertainties are as important as the mean!
- **Multiple Critical Configurations**
 - To determine reproducibility
 - With various reflectors to modify neutron spectrum
- **Examine More than Critical Configuration**
 - Sub-critical and super-critical
 - External neutron and gamma spectra
 - Internal foils and detectors to measure reaction rates and reaction products

Specific Objectives of Proposed Experiments (1)

- **Reaction rate and fission-product yield measurements in Pu-239 and U-238,235**
 - Address known deficiencies in our current understanding of fission chain yields in various neutron spectra
 - Reestablish experimental capability (radiochemistry and nuclear physics) relevant to stewardship and NTNF
 - Note that several LANL radiochemists are planning to tour CEF in March (hosted by John Bounds) to better understand ancillary capabilities at CEF and to prepare for initial experiment.
- **Probability of Initiation Benchmark Experiments**
 - Develop a set of documented experimental data that is specifically designed to test our ability to compute the probability of initiating a divergent neutron chain reaction

Specific Objectives of Proposed Experiments (2)

- **Measure the Fission Neutron Spectrum Shape Using Threshold Activation Detectors**
 - We propose to measure reaction rates on several threshold detectors in different regions (spectra) of critical assemblies to reduce the current uncertainty in the shape and magnitude of the high-energy tail of the prompt neutron fission spectrum.
 - This experiment would complement ongoing theory improvements and the “Chi-Nu” detector system being constructed at LANSCE that will measure the PNFS tails directly.
- **Be Reflector Studies**
 - There is a need to resolve the fact that existing suites of ICSBEP HEU-Be systems (HMF58, HMF66, and HMF77) have inconsistent C/E ratios based on ENDF/B-VII.0
 - This experiment would build on IER 137, and would complement updated R-Matrix evaluation work and RPI scattering experiments on Be-9.

Summary

- **Over a seven-month period, numerous Los Alamos staff came together to brainstorm, discuss, refine, and prioritize potential CEF experiments of value to stockpile stewardship and global security.**
- **As of today, the result is eleven Integral Experiment Requests currently working through the NCSP C_EdT process.**
- **We are enthusiastic about the prospects of seeing these experiments performed, and committed to communicating the value to our programmatic sponsors.**